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Evaluating the resource recovery potential of fly ash deposits using electrical and electromagnetic methods

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Burning coal, or municipal solid waste, in thermal power plants and in metallurgical industries is responsible for the production of large amounts of combustion residues, which depending on their particle size and density, are usually referred to as fly or bottom ash. Nowadays, they represent one of the main types of industrial waste generated. Although their composition is strongly dependent on the material burned, they typically contain ferro-aluminosilicate minerals with potentially toxic trace elements and inorganic compounds that can cause environmental problems when stored in non-sanitary landfills. At the same time, they also represent an economically interesting secondary resource as they can be valorised by replacing aggregates/additives in cement or ceramics production. Surprisingly, despite the environmental and economic considerations for these materials, their geophysical properties remain largely unknown. A better understanding of their geophysical identity could enable using geophysical methods to, for example, improve the estimation of the volume and quality of recoverable resources from ash deposition sites. In this contribution, we show the results of geophysical investigations carried out in three of these sites located in Belgium. The main geophysical techniques involved are electrical resistivity tomography, time-domain induced polarization and frequency-domain electromagnetic induction. The deposits studied generally exhibit high electrical conductivity presumably due to the high hygroscopy of fly ash, the high chlorides content and the presence of ferro-aluminosilicate minerals, each of which enhancing electrical conduction mechanisms, although the effect of the first two is conditioned by the level of water saturation present. The presence of magnetite, or other ferri- or ferromagnetic materials, may explain the high magnetic susceptibility observed. Yet, while representing a relatively homogeneous type of waste, strong variations in geophysical properties were observed between and within different sites. This suggests a great influence of the ash production process, but also of the site-specific conditions. These first results argue for further field and laboratory experiments to validate the exploratory geophysical survey results and to identify the decisive influencing factors explaining the observed electrical and magnetic response. Improved insight in the geophysical signature of fly ash deposits will allow for more accurate interpretations of geophysical measurements, in its

turn providing a more sound basis for guiding conventional sampling design and thereby contributing to a more reliable assessment of the value of these industrial waste landfills in terms of the secondary resources they can deliver.